11 MAY 2021 TUESDAY

3:00pm ~ 4:30pm (SGT)
9:00am ~ 10:30am (CET)

Coordinated and co-organized in Denmark by the following partners:

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WATER RESOURCE RECOVERY

An Online dialogue between **Denmark** and **Singapore**
on key innovations and opportunities ahead in the water sector

SWA Singapore Water Association

DANISH EXPORT ASSOCIATION WATER

Supported by :

EMBASSY OF DENMARK Singapore

PUB SINGAPORE'S NATIONAL WATER AGENCY

Ministry of Environment of Denmark
Environmental Protection Agency

WELCOME

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Housekeeping

- ✓ **To ensure better connectivity, please mute your microphone and turn off the camera. You may communicate with us after the event.**
- ✓ **Please share your questions in Q & A icon (right bottom) where we will try to provide answers where possible in each Segment.**
- ✓ **Do identify yourself so we can respond to any unanswered questions**
- ✓ **We will be recording this session and reserve the rights to the video**
- ✓ **Please complete a 1min poll survey at end of the session. We will forward the recording and presentation deck to the respondents.**

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Welcome Address from the Royal Danish Embassy

H.E Ambassador Ms. Sandra Jensen Landi (Moderator : Mr Mark Perry)

EMBASSY OF DENMARK Singapore

A Water Perspective to Resource Recovery

PUB Singapore National Water Agency, Dr Pang Chee Meng, Chief Engineering & Technology Officer

PUB SINGAPORE'S NATIONAL WATER AGENCY

Regulation as a driver for wastewater management and resource recovery in Denmark and in Europe

Ministry of Environment of Denmark, Mr. Jóannes Jørgen Gaard, Special consultant

Ministry of Environment of Denmark
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Panel discussion: Implementation, drivers and ecosystems of a resource recovery roadmap

Moderator: Ms. Helle Katrine Andersen, Head of DANVA secretariat and Chair of IWA-Denmark, DANVA (Danish Water and Wastewater Association)

Panellists :

Nick Ahrensberg, Project Manager & Senior Water Resources Advisor, Biofos, Denmark's largest wastewater utility treating wastewater in Greater Copenhagen
Christian Nyerup Nielsens, Director, Climate Adaptation & Landscape, Ramboll Water
Dr Mamta Jain, SWA Council Member, Director of Business Consultancy, DHI Water Environment
Kunal Shah, SWA Council Member, Managing Director of Anaergia Inc (Asean)

Resource Recovery: Innovation and solutions of tomorrow

Moderator: Mr. Allan Han-Huei Teo, managing director of Quercus Group in Singapore

Speakers :

Mr. Christian Wieth, Chief Commercial Officer, AquaGreen ApS
Mr Guah Eng Hock, Director, SG Enviro Pte Ltd
Mr Ryan Kwa, Operation Manager, Novexx Pte Ltd

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EMBASSY OF DENMARK
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A Water Perspective to Resource Recovery

PUB Singapore National Water Agency
Dr Pang Chee Meng
Chief Engineering & Technology Officer

PUB SINGAPORE'S NATIONAL WATER AGENCY

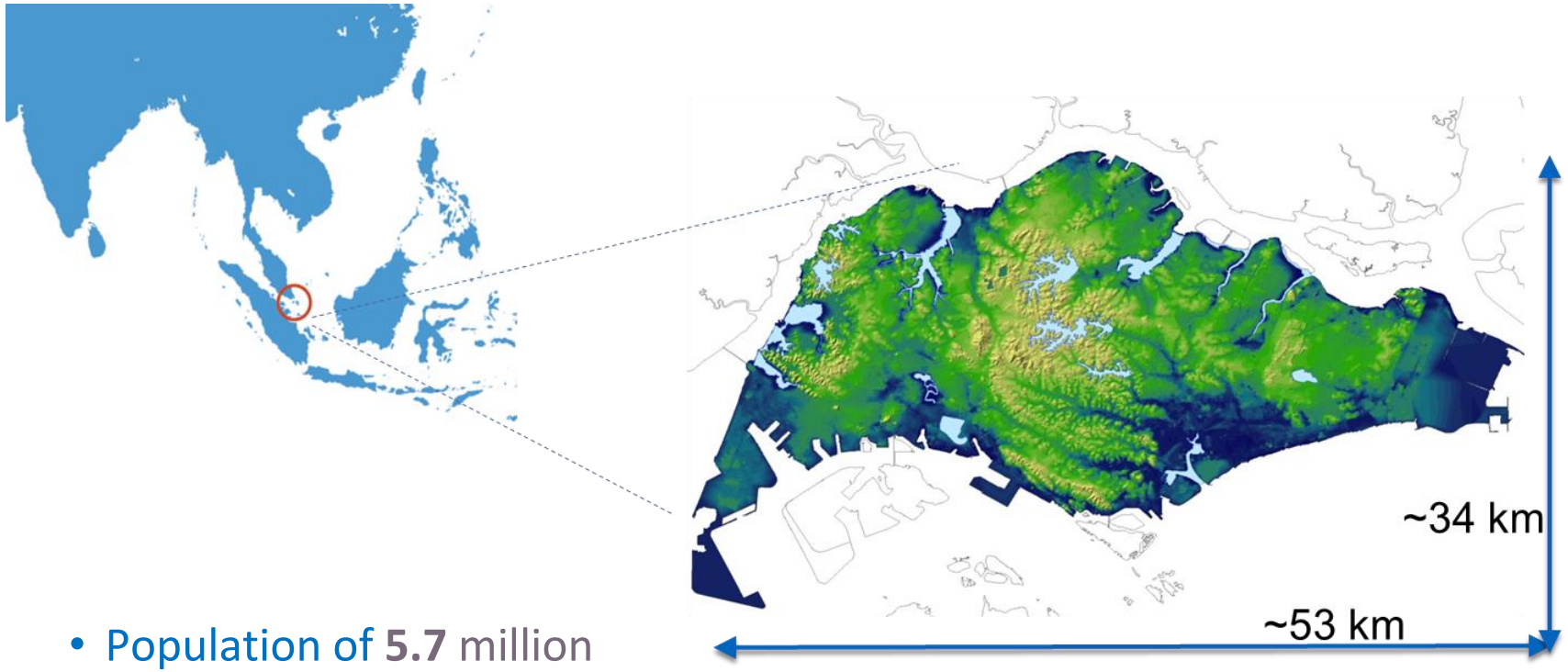
PUB SINGAPORE'S NATIONAL WATER AGENCY

A Water Perspective to Resource Recovery

Dr. Pang Chee Meng

Chief Engineering and Technology Officer

Singapore and its Challenges



- Population of **5.7** million
- Land area of **721** km^2
- Average annual rainfall **2166** mm
- Average Water Demand:**1.9mil m^3/day**

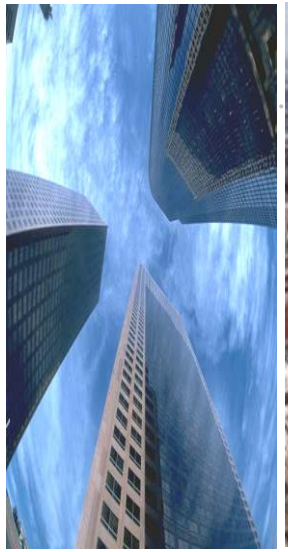
Challenges

☹ Land Constraint

☹ Water Scarcity & Increasing Demand

☹ No Natural Resource

☹ Aging Population & Rising Expectations




Ministry of Sustainability and the Environment
SINGAPORE

"To ensure a clean, sustainable environment, and supply of water and safe food for Singapore."

National Environment Agency
Safeguard · Nurture · Cherish

"To ensure a sustainable quality environment in Singapore"

- ***Clean Land***
- ***Clean Air***
- ***Public Health***

PUB SINGAPORE'S NATIONAL WATER AGENCY

"To ensure an efficient, adequate & sustainable supply of water"

- ***Clean Water***

A Statutory Board constituted under the Public Utilities Act 2001 to provide integrated water supply, sewerage and drainage services

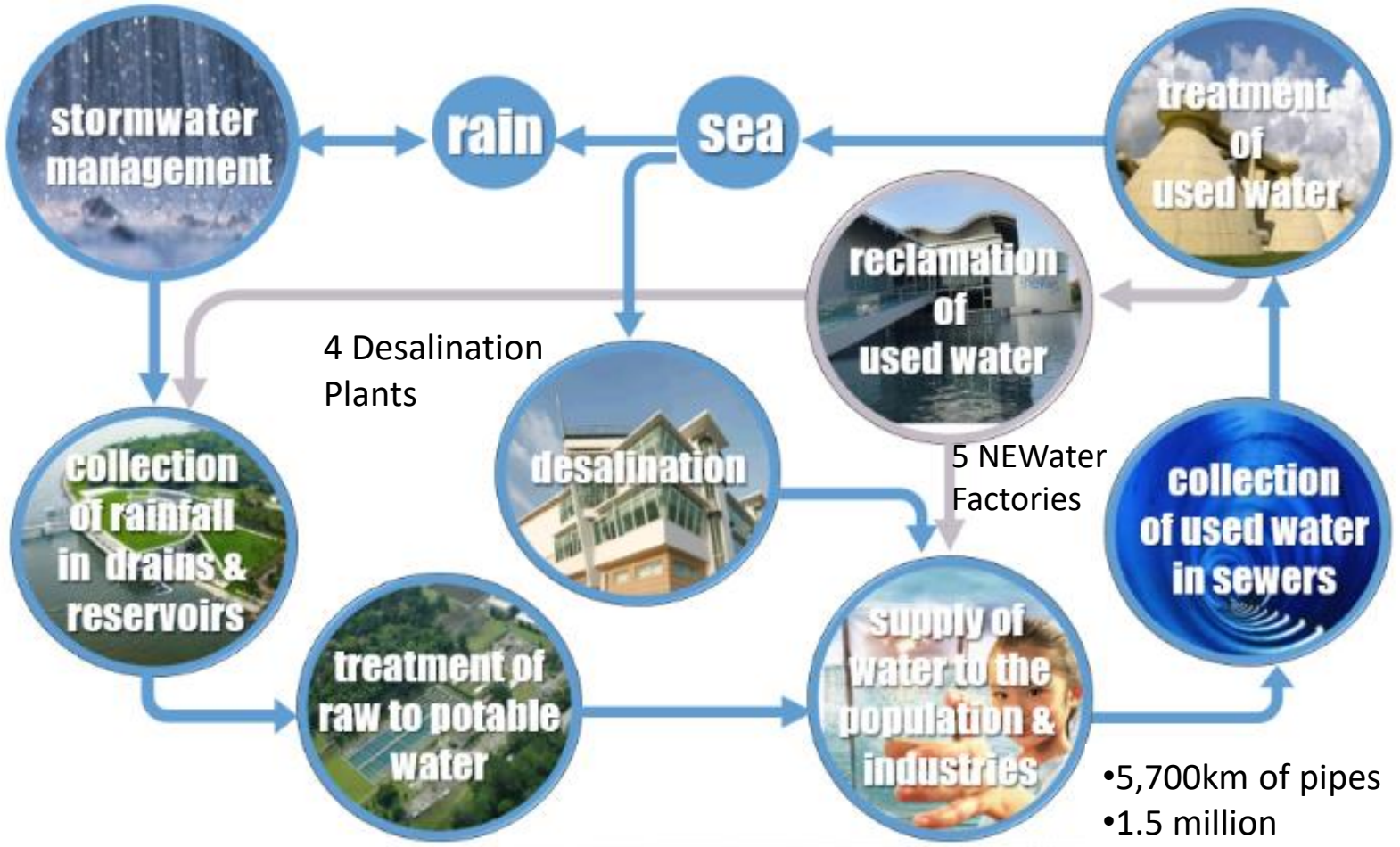
Singapore Food Agency

"To ensure and secure a supply of safe food"

- ***Safe Food***

PUB's Mission

17 surface water reservoirs



4 Water Reclamation Plants

4 Desalination Plants

8,000 km of drains, rivers and canals

5 NEWater Factories

•48 km of deep tunnel
•3,500km of public sewers
•90,000 manholes

7 Waterworks

•5,700km of pipes
•1.5 million customer accounts

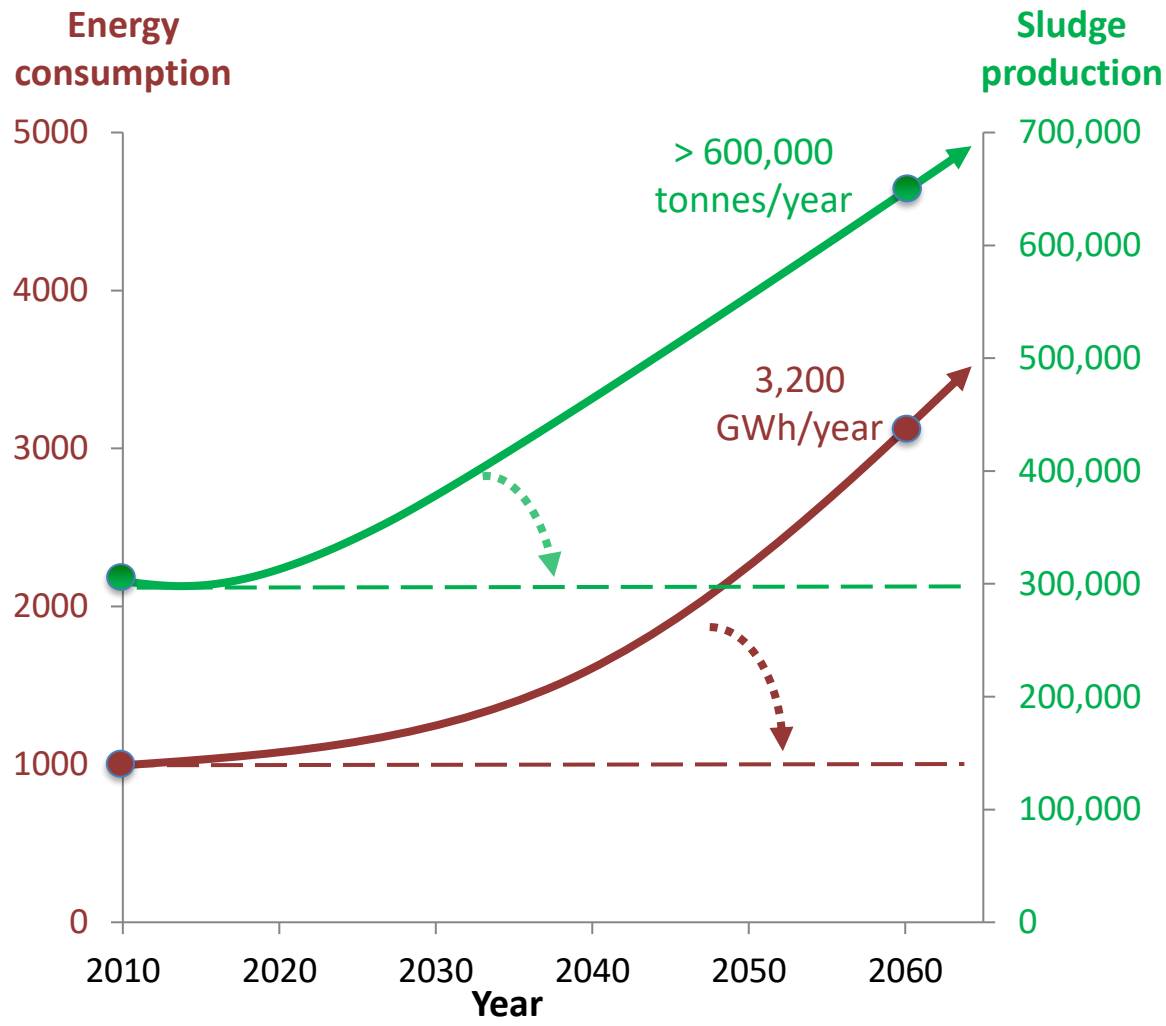
Long-Term Goals

Can we meet water demand in 2060 at 2020's energy and sludge footprint?

Water demand in 2060
= 2x more

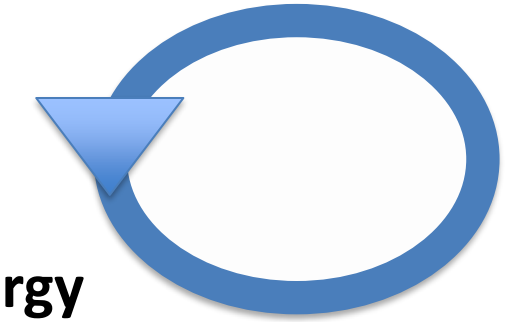
Energy Needed = > 3x more

Sludge Generated = 2x more



Water-Energy-Waste Nexus

Water: Every Drop is Precious



Energy Efficiency + Generation + Substitution

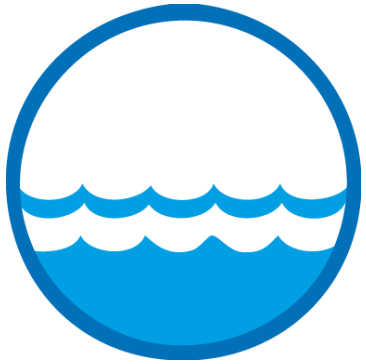
Waste as a Resource

Sludge → **NEWSand**

Water: Every Drop is Precious

Water Resource

Capture every drop of rain



Desalinate more seawater

Reuse water endlessly

Water Conservation

130 litres per capita per day by 2030

3MGD/year water savings from the industry

Energy Efficiency + Generation + Substitution

Efficiency

- Next Generation Membranes/ Equipment
- Digitalisation

Generation

- Energy Neutral Water Reclamation Plants

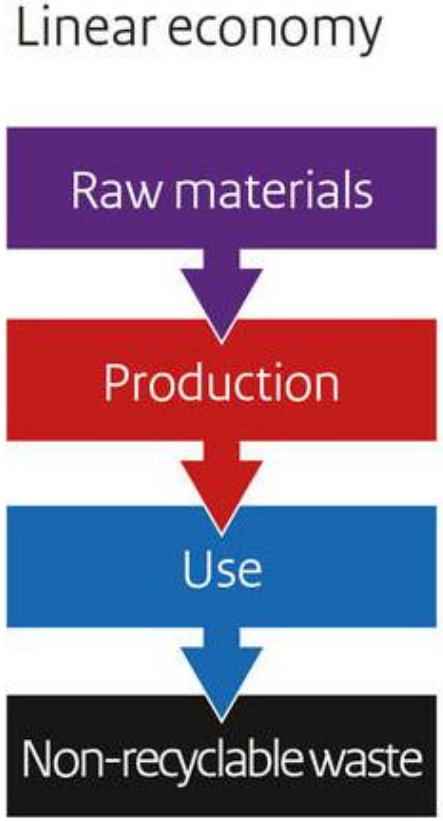
Substitution

- Solar Energy
- Pressure Retarded Osmosis (PROs)

Waste as a Resource

Vision of a Zero Waste Nation

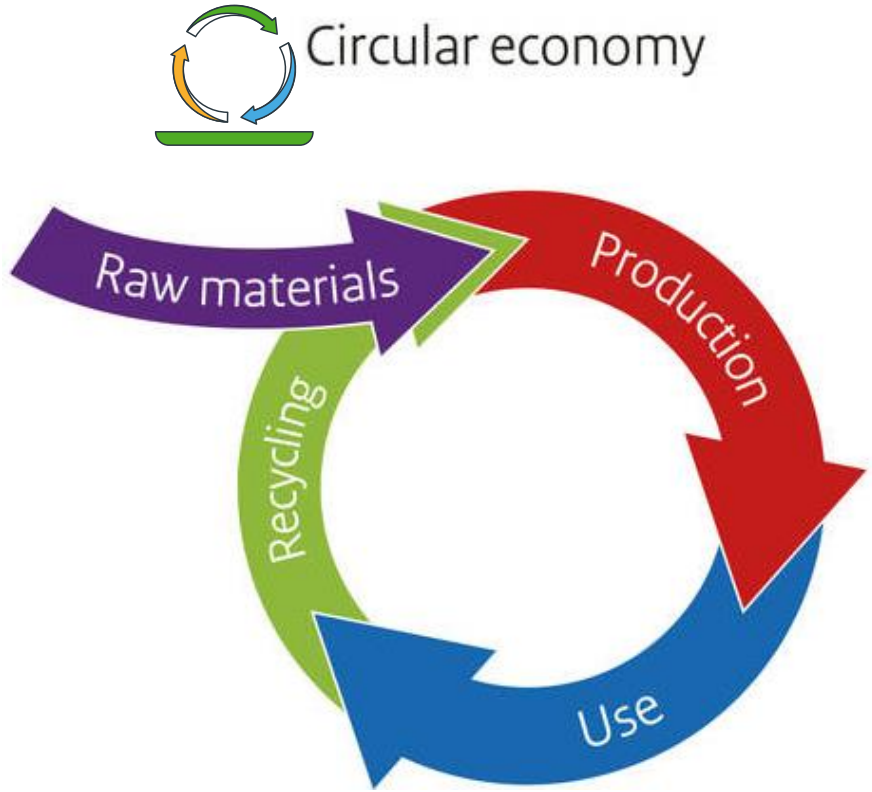
❖ **Reduce the amount of waste sent to landfill (per capita) by 30% by 2030**



Problem Statement for Linearity

- Resource constraint and scarcity
- Semakau Landfill to run out of space by 2035

Source: Semakau Landfill



Achieving Zero Waste for PUB

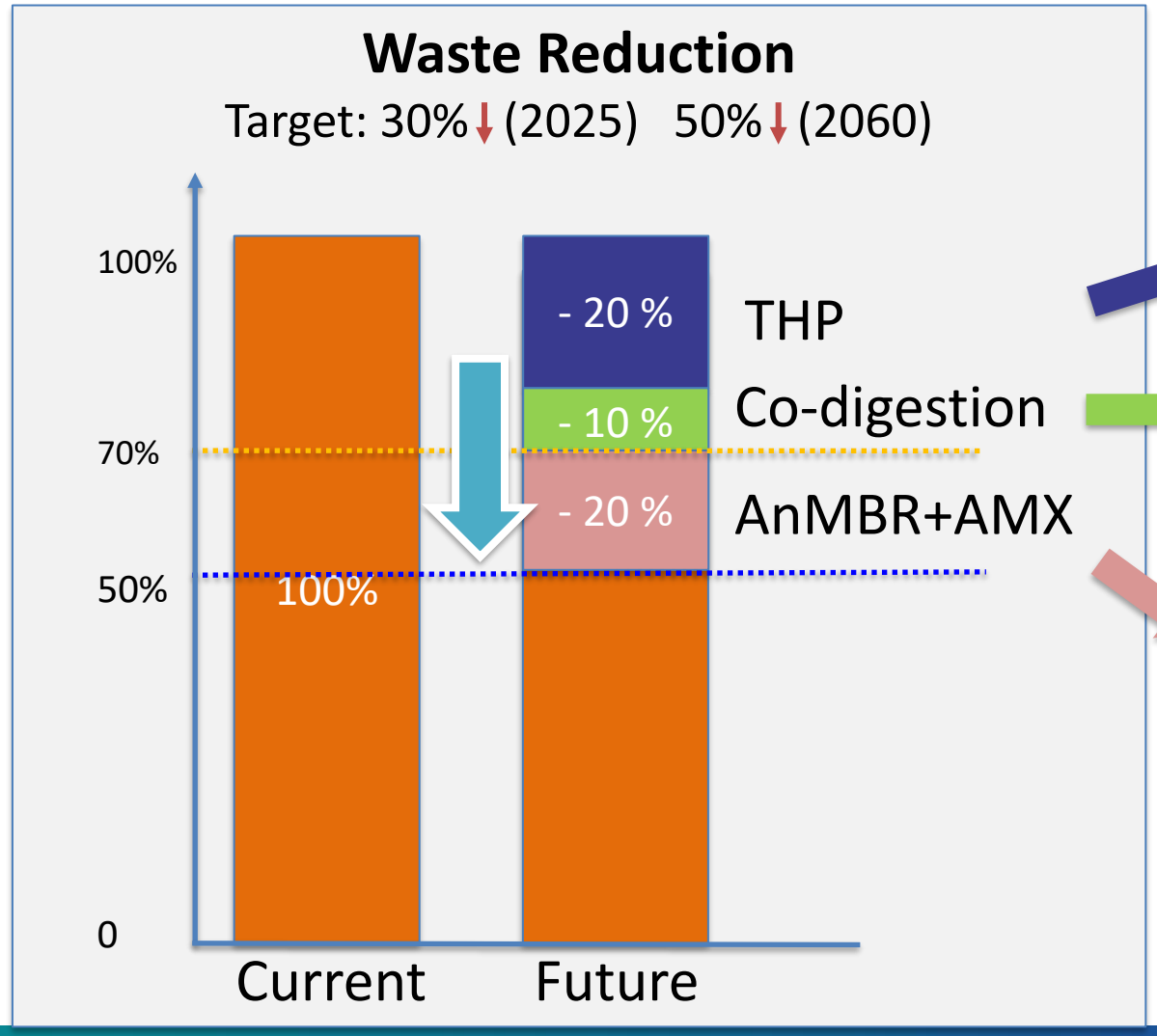
Target:

To reduce sludge sent to landfill

Approach 1:
Produce Less Sludge

Approach 2:
Resource Recovery
from Sludge

Approach 1: Produce Less Sludge



Used Water Sludge

Thermal Hydrolysis – increase the VS reduction rate through pre-treatment of sludge

Co-digestion of food waste and sludge – synergistic effect to increase the VS reduction rate by co-digestion.

MBR operating under anaerobic conditions, where organics are directly converted into biogas (CH_4), producing less sludge.

Approach 2: Resource Recovery from Sludge

PUB

Incineration Plant

Landfill

WRP

WSP

Dewatered + Dried Sludge

Waterworks Sludge

Incinerated Ash

Useful Products

Waste to Landfill

High Cost of Disposal

TARGET: Close the Waste Loop
BENEFIT: Preserve Landfill + Cost Saving

Opportunities for Recovering Resources

Biochar for Urban Farms

Pyrolysis

Sludge as a Resource

Gasification

NEWSand

Biocrude Oil

Hydrothermal

New Tech?

Bioplastics?

<u>Key Question</u>: Are the products for the Singapore market or are exportable?

Singapore Green Plan 2030

SG GREEN PLAN

5 Pillars of Singapore Green Plan 2030

- City in Nature
- Sustainable Living
- Energy Reset
- Green Economy
- Resilient Future

Green Government and Green Citizenry as Key Enablers

SINGAPORE INTERNATIONAL WATER WEEK 2021

THE GLOBAL PLATFORM TO SHARE AND CO-CREATE INNOVATIVE WATER SOLUTIONS

SIWW2021 SPOTLIGHT

21 June 2021

- Theme: Fostering Innovation and Collaboration to Build Sustainable Outcomes
- High-Level hybrid Summit for Water Leaders
- ~250 physical attendees, with optional virtual participation
- Co-located with World Cities Summit
- Keynotes by Singapore Deputy Prime Minister, and the Minister for Sustainability and the Environment

SIWW2021 ONLINE

21 June – 2 July 2021

- Ten-day virtual event for Leaders, Experts and Practitioners
- Comprehensive suite of online content covering the entire urban water cycle and emerging issues such as resource recovery, climate resilience, and digital water
- Virtual SIWW Water Convention and Water Expo
- Content includes thematic webinars, case studies. keynotes, workshops, technical presentations, and product showcases

Statistics are based on Singapore International Water Week 2018

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Regulation as a driver for wastewater management and resource recovery in Denmark and in Europe

Ministry of Environment of Denmark
Mr. Jóannes Jørgen Gaard
Special consultant

Ministry of Environment of Denmark
Department

Regulation as a driver for wastewater management and resource recovery in Denmark and in Europe.

Denmark-Singapore Water Dialogue?
Virtual, 11. Mai 2021
Jóannes J. Gaard

Agenda

1. **Discharges of nutrients**
2. **Emission of GHG**
3. **Ressource recovery**
    a) Energy
    b) Phosphorus
    c) Carbon

Discharges of Nutrients

	Nitrogen	Phosphorous
UWWTD	10-15 mg/l	1-2 mg/l
The Danish Wastewater Order	8 mg/l	1-1,5 mg/l
Actually discharges	4,79 mg/l	0,47 mg/l

Drivers for discharge levels

International level:
- SDG goal 6.3

EU level:
- Water Frame Work Directive – good condition
- Urban Waste Water Directive

National level: New Danish regulation
- The Wastewater Order
- Tax on discharges of nutrients to sea or fresh water
- Water areas plans – good condition

Local level:
- Discharge permits adapted to local conditions
- Professional pride

Tax on discharges of nutrients to sea or fresh water (2021 prices)

Nitrogen	Phosphorous
5 Euro pr. kg	23,4 Euro pr kg

Climate plan for a green waste sector and circular economy

The Danish ‘Climate plan for a green waste sector and circular economy’ from June 2020 establishes that the Water sector in Denmark should be Energy- and Climate Neutral by 2030

1. Limit values for nitrous oxide emissions are introduced

2. Guidance regarding removal of lime in drinking water

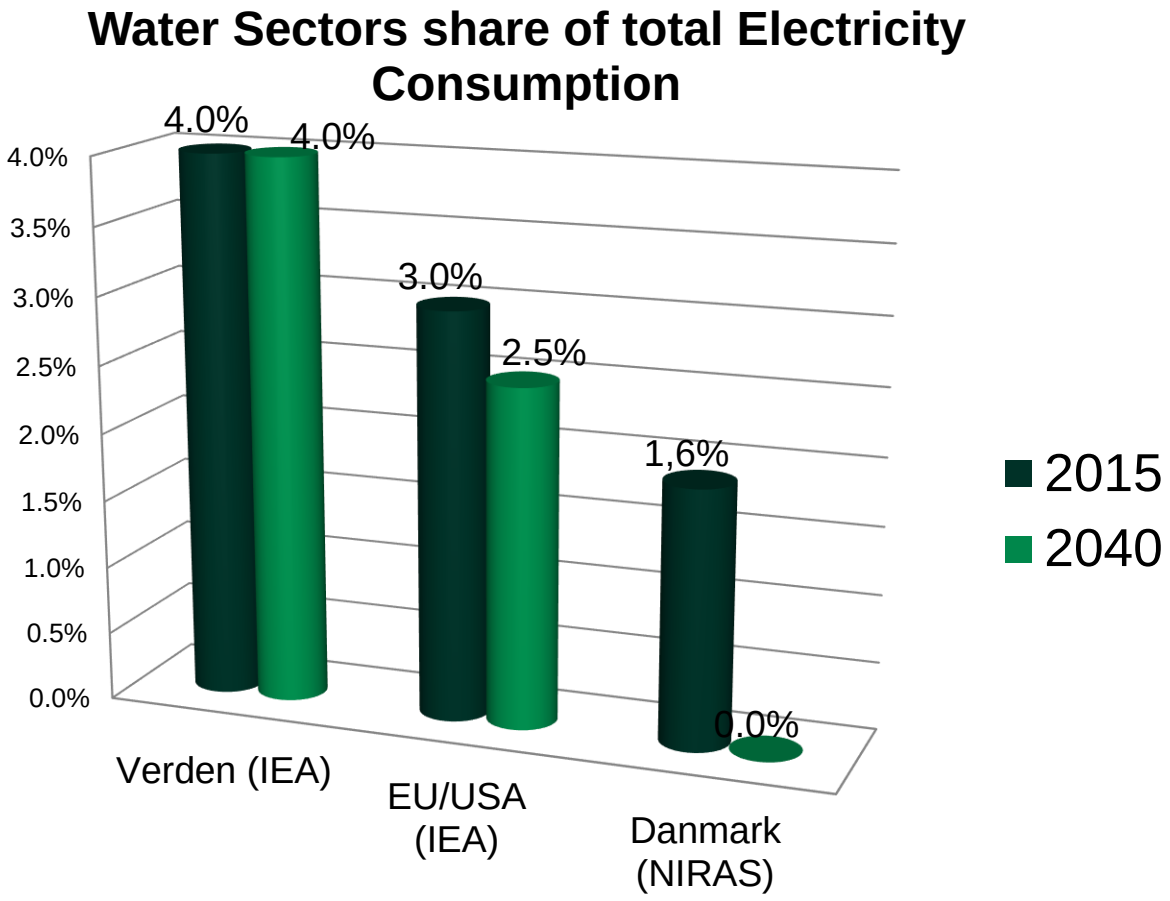
3. A Paris model is implemented for an energy- and climate-neutral water sector

4. Economic incentives for inceniration of sludge/phosphorus are removed

5. Examine whether economic regulation can be designed so that wastewater companies have stronger incentives to use their own resources efficiently for the benefit of consumers

6. It is examined what effects a consolidation of the sector will have on circular economy

Trends in Waste Water treatment in Denmark



Energy production at Danish Waste Water Plants			
	Consume, mWh	Production, mWh	Production share of Consume, %
Sewer system	111.736	613	0,55%
Waste Water Plant	431.812	381.542	**88,4%**
Total	543.548	382.155	70,3%

Danish EPA: Performancebenchmarking 2019

An energy- and climate neutral Water Sector in 2030

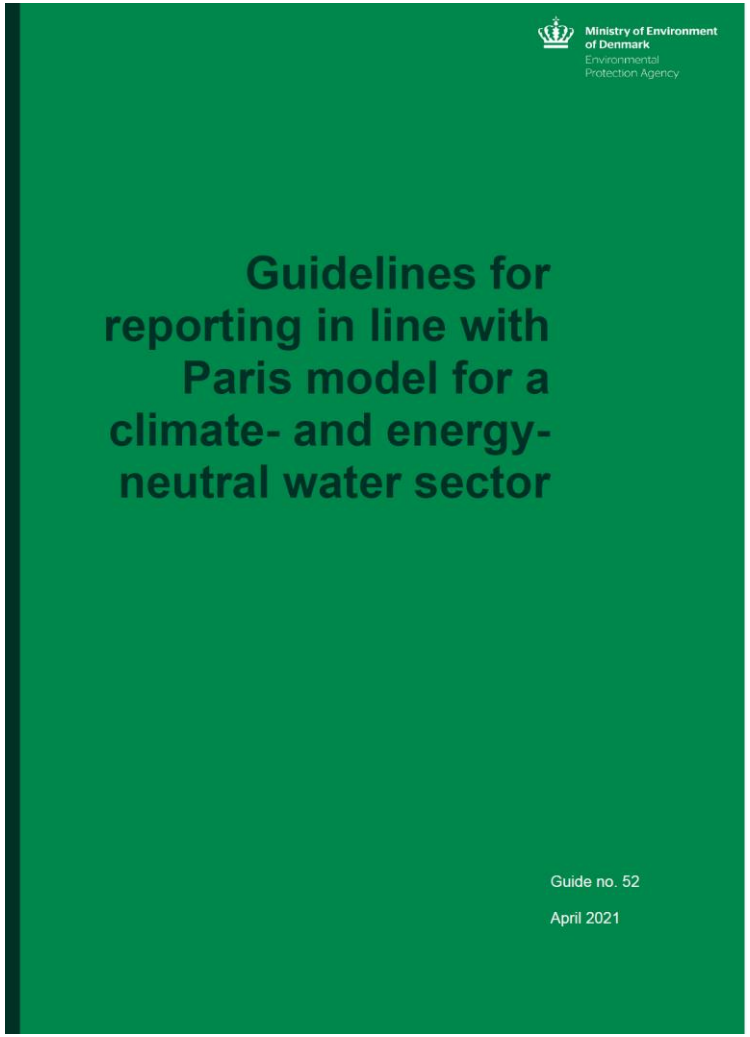
All Waste Water Companies will be benchmarked on:

Energy Comsumption and production
- Electricity
- Heat – oile, gas, district
- Biogasproduction

Methane emission
- septic tanks
- biogas production

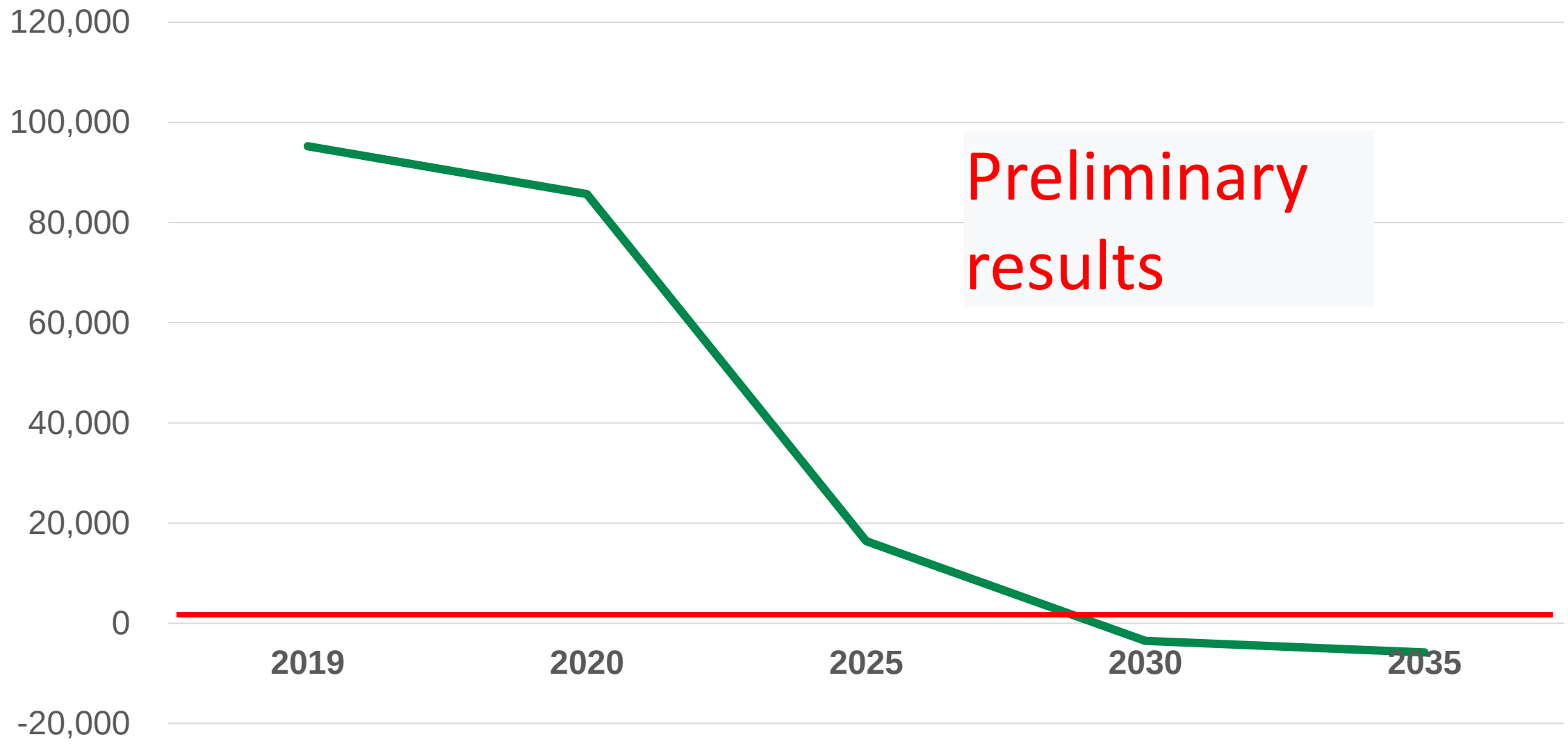
Nitrous oxide emission
- Discharges
- Proces on WTTP

Nitrous oxide avoidance
- Cleaning

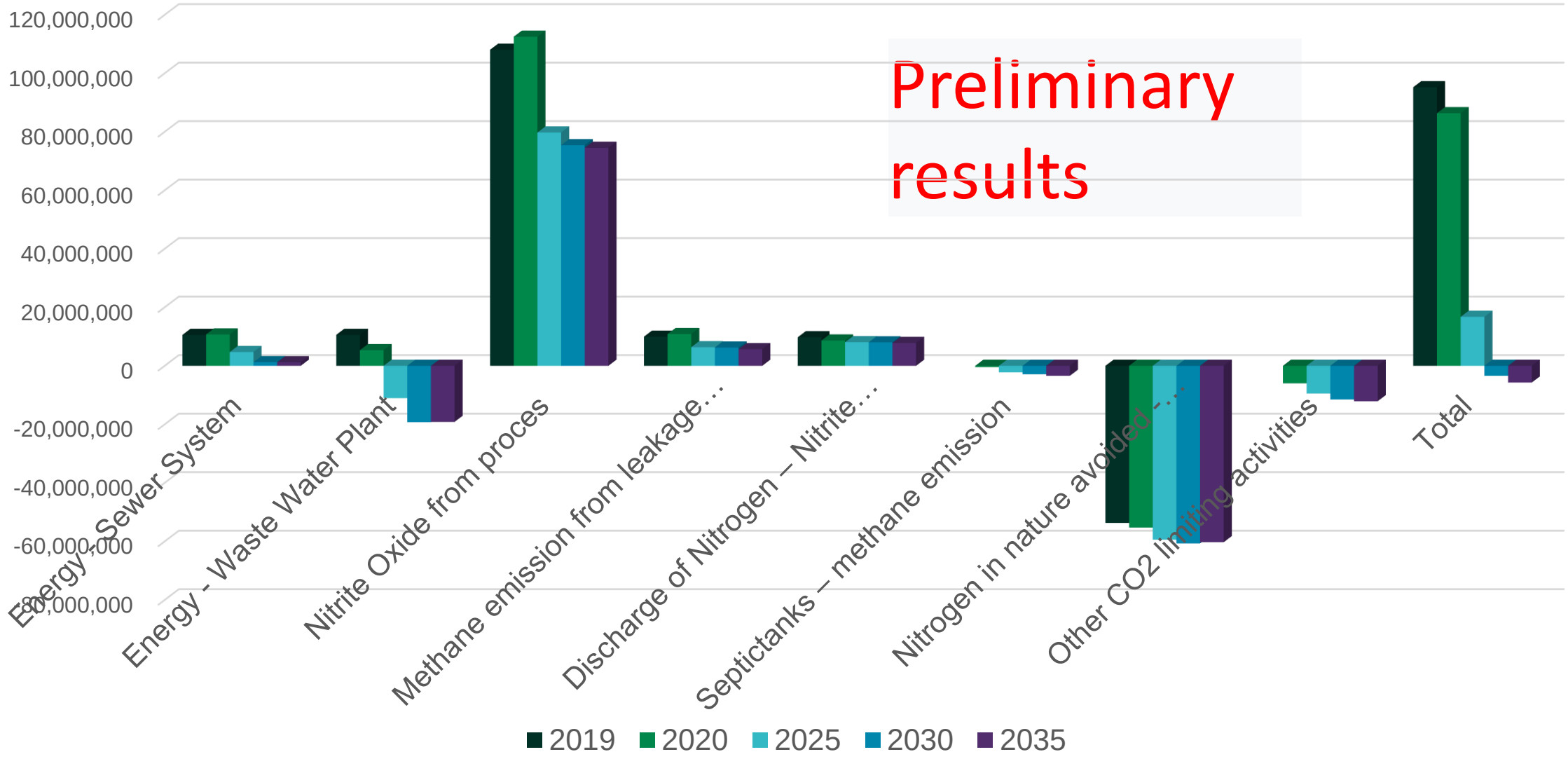


https://www2.mst.dk/Udgiv/publications/2021/04/978-87-7038-298-4.pdf

CO2 effect - Danish Waste Water Sector (ton Co2 equivalent)



Development i elements of C02 impact in the Danish Waste Water Sector



Drivers for Climate neutrality

International level:

- Paris agreement and SDG goals – all sectors must commit

EU level:

- EU goal on 55 percent reduction of CO2 emission in 2030
- Water Frame Work Directive – Nitrous discharges
- Sector Integration Strategy– upgrade biogas to nature gas network

National level: New Danish regulation

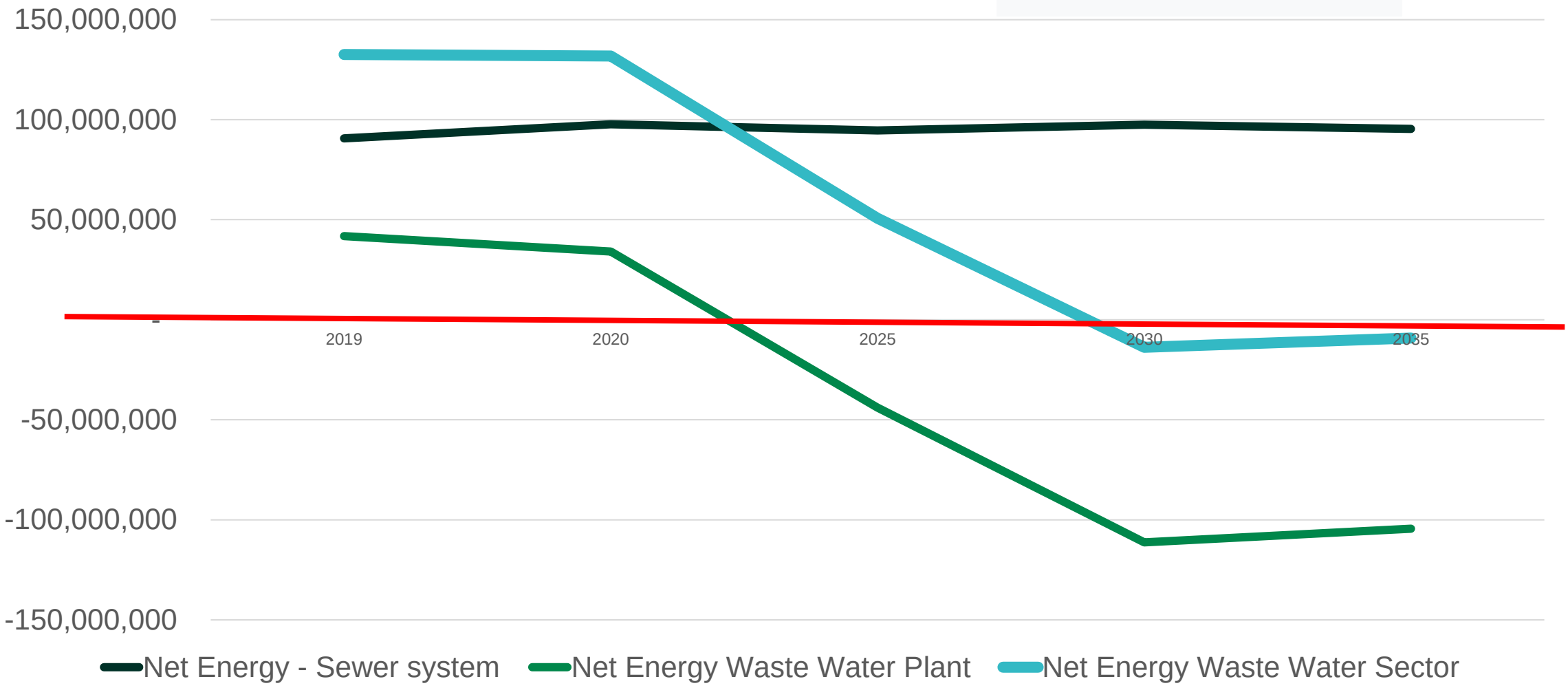
- National goal on 70 percent reduction of CO2 emission in 2030
- National goal on climate neutral Water Sector
- By 2025 there will limit values for the nitrous oxide emissions from WWTP with a capacity on 30.000 PE or more, that can reduce the emissions with 50 percent
- High prices on green electricity

Local level:

- Climate ambitions in the Utilities / Municipalities
- Possible CO2 emission pricing

Net Energy Danish Waste Water Sector - kWh

Preliminary results



Drivers for Energy neutrality

International level:
- Paris agreement and SDG goals

EU level:
- EU – ECO-design requirements for water pumps

National level: New Danish regulation
- An energy netral watersector in 2030
- High prices on green electricity

Local level:
- Company economy – energy price
- Energy ambitions in the Utilities / Municipalities

Ministry of Environment of Denmark
Department

Thank you for your attention!

Virtual 21. April 2021

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Kunal Shah, SWA Council Member, Managing Director of Anaergia Inc (Asean)

Water resource recovery – A dialogue between Denmark and Singapore on key innovations and opportunities ahead in the water sector

BIOFOS

From traditional WWTP to Resource Recovery and Carbon neutrality

Nick Ahrensberg
Senior project manager

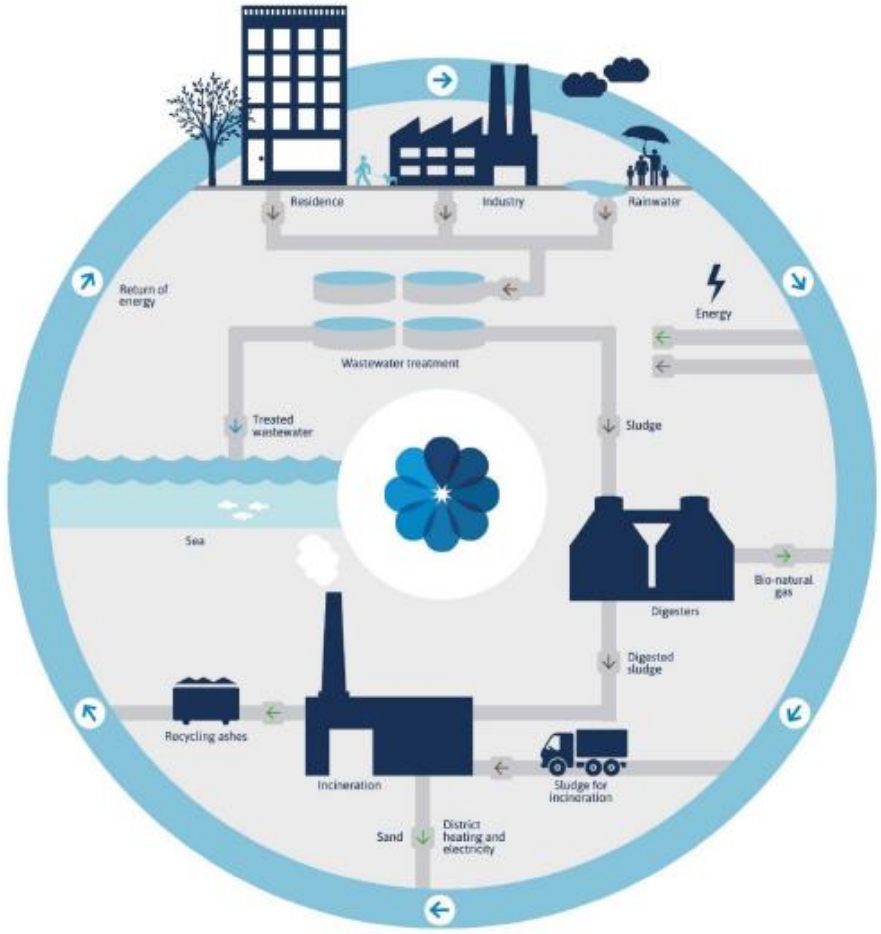
BIOFOS

BIOFOS is the largest wastewater utility in Denmark.

We treat the wastewater of 1.2 million people living in the Greater Copenhagen Area at our three treatment plants

BIOFOS

Waste as a ressource – Circular economy



BIOFOS – Strategy 2020-25

Compliance with seven of the UN-Sustainable Development Goals

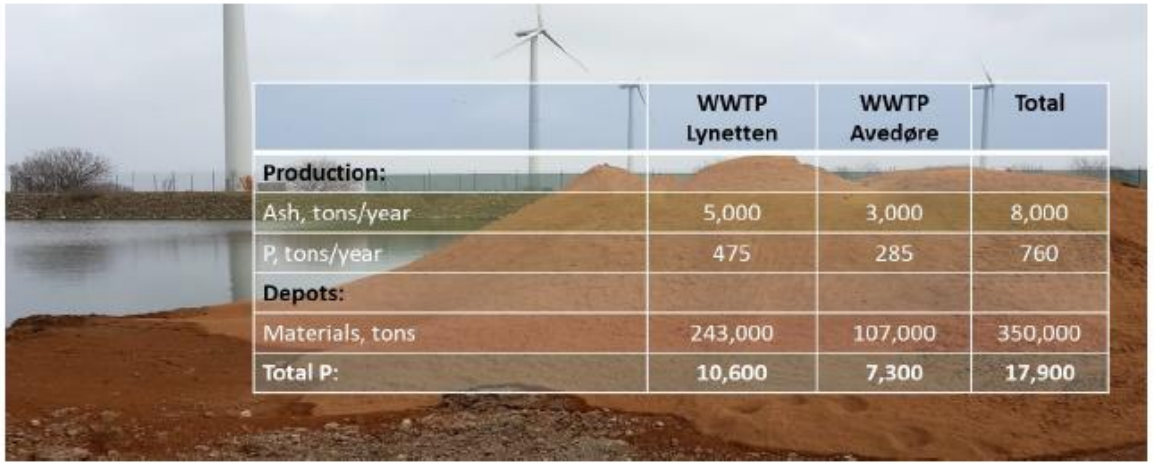
Further improvement in treatment efficiency

All residual products from our core processes will be recycled or made use of from 2025 e.g. phosphorus from sludge ash & reuse of silicate sand

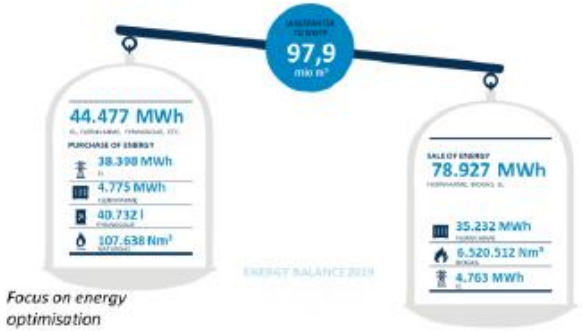
BIOFOS as a whole is carbon absorbing by 2025

Continuous increase in energy production

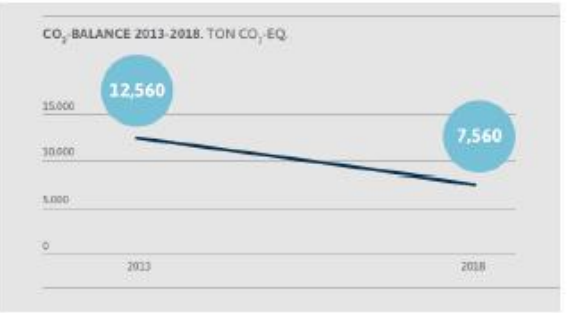
Active player in innovation and development of new technologies



	WWTP Lynetten	WWTP Avedøre	Total
Production:			
Ash, tons/year	5,000	3,000	8,000
P, tons/year	475	285	760
Depots:			
Materials, tons	243,000	107,000	350,000
Total P:	**10,600**	**7,300**	**17,900**



Focus on energy optimisation



Thank you for your attention

BIOFOS

WATER RESOURCE RECOVERY

Christian Nyerup Nielsen, cnn@ramboll.dk
Ramboll
Global Division Director, Climate Resilience and Water Resource Management

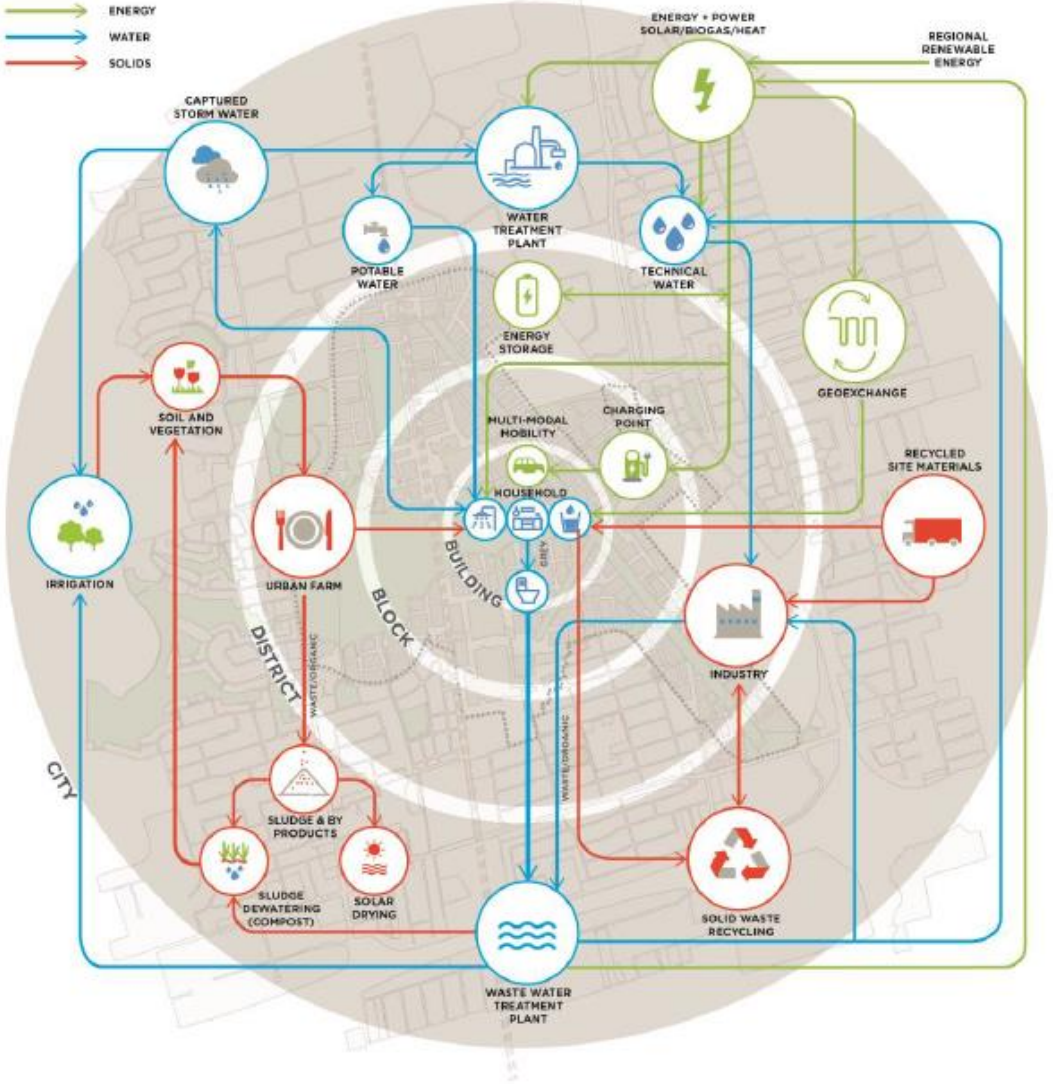
RAMBØLL

BISHAN PARK
CAPTURE AND TREAT - RAIN WATER AND RUNOFF

BISHAN PARK
RE-USE OF MATERIALS

TUNNELING
OPTIMIZE DESIGN PARAMETERS

DOWNSVIEW MASTER PLAN
WATER CONSERVATION AND RECOVERY AT DISTRICT SCALE



RAMBOLL Bright ideas. Sustainable change.

COPENHAGEN CLOUDBURST FLOODSHED PLANS
INDIVIDUAL KPI'S FOR EACH PROJECT

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Mr. Christian Wieth, Chief Commercial Officer, AquaGreen ApS
Mr Guah Eng Hock, Director, SG Enviro Pte Ltd
Mr Ryan Kwa, Operation Manager, Novexx Pte Ltd

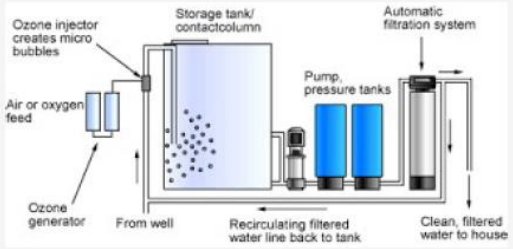
SG ENVIRO

Advanced Oxidation Process (AOP) using Non-Thermal Plasma Technology

How it works:

1. Plasma Remote System → AOP Water Treatment

Plasma generate Ozone and active radicals



2. Plasma In-Direct System → UV water treatment

Plasma generate UV Lights

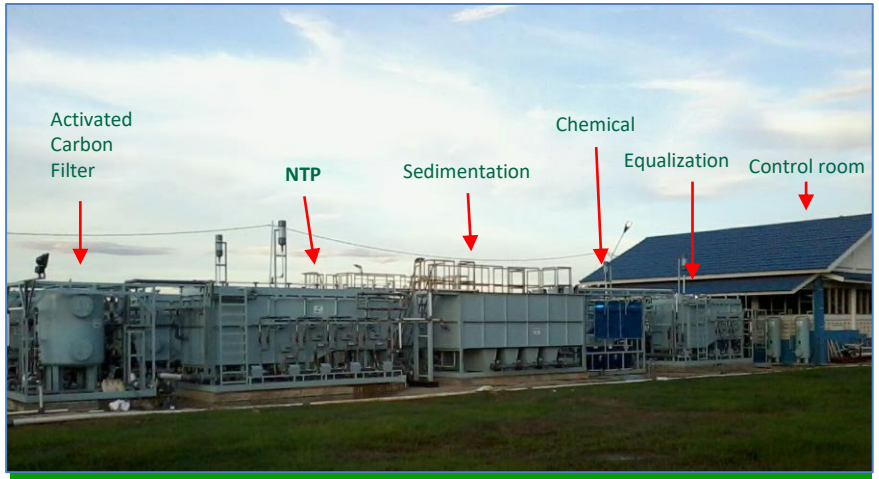
3. Plasma Direct System → Plasma water treatment

Plasma Generate Active Species (•OH, • O, O3, H2O2) in Water

Versatile Application across multiple Industries



Oil & Gas / Mining



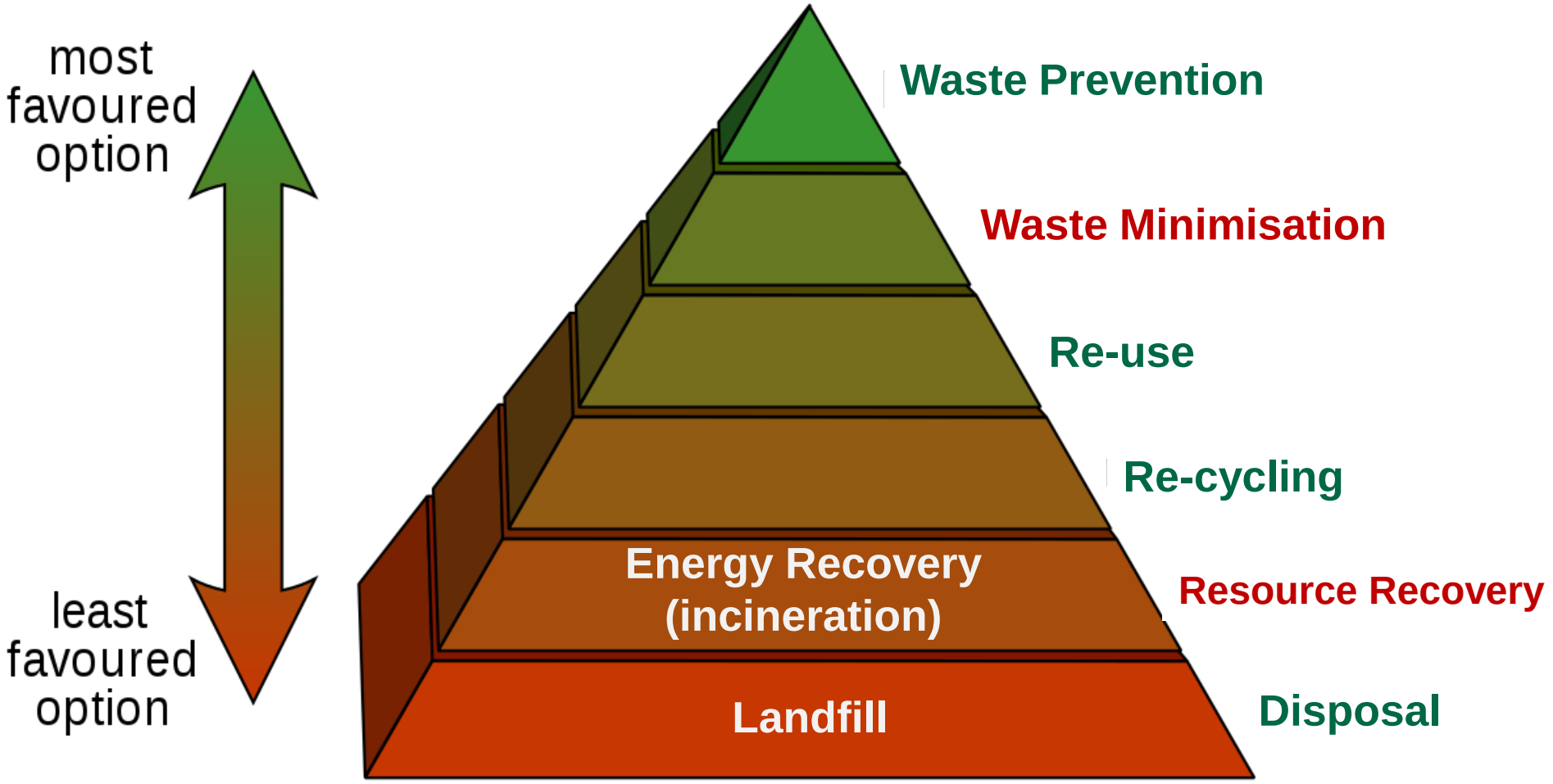
Industry – Palm oil, Gold Mining, Detergent plant, sugar mill etc

Aquafarming – Shrimp / Fish Farm

Waste Water Recycling – Apartment / Offshore platform


River Decontamination / Odour Removal

Waste Hierachy



Technical Innovation and Challenges of the Project:

- Caverns are unlined
- Cavern Roofs are below groundwater table
- Water Curtain Gallery creates water pressure keeping oil within the cavern

Innovations in the Project

Current

Waste Minimisation

- Sludge reduction using AOP

Reduce

- Minimization of Chemical Usage

Recycling

- Treated Water is Recovered and re-injected into WCG

Future

Resource Recovery

- Investigate the recovery of minerals from sludge (separation of sludge stream)

- CO_2 capture

Advanced Oxidation Process (AOP) using

Non-Thermal Plasma Technology

Guah Eng Hock, Director

SG Enviro Pte Ltd

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Novexx Pte Ltd

Service Knowledge Commitment

INTRODUCTION

- **Novexx** was founded by a group of refinery and pharmaceutical engineers in 2001.
- We provide a diverse range of services in engineering, plant maintenance & construction, validation, HAZOP (Singapore & China), training curriculum development, industrial training and human resource management.
- **Novexx** is also the regional representative of **Raschka Engineering (formerly known as Lonza Engineering)**, a Swiss based company specialising in pharmaceuticals, waste-to-energy / waste management solutions and engineering services, including **hazardous industrial wastes (solid, liquids, gas, sludges) incineration systems**.

SPECIALISES IN:

- Petrochemicals
- Pharmaceuticals & Lifescience
- **Industrial Waste Waster Treatment using Advanced Oxidation Process**
- **Renewable / Waste-to-Energy Technologies**
- **Fluidized Bed Incinerator**

Advanced Oxidation Technology

Reaction Treatment System

- Primary Oxidation reaction to break the solubility of the **dissolved ORGANIC** contaminants

- Largely dependent on the **composition** and **concentrations**

- High oxidizing properties of hydroxyl radical breaking down long hydrocarbon chain into CO_2, water and ions. Hence **minimal or no sludge is produced**.

- Challenge is to **Generate Low Cost Strong Oxidation Material** versus the conventional method, e.g. Ozone, UV, Hydrogen Peroxide etc.

Advanced Oxidation Technology

SHR

Static Hydro Reactor

Proprietary multi-function media modules and compressed air to breakdown and specifically designed to:

- Create an oxidation-reduction reaction with the type of pollutant to be treated
- Coagulate and absorb the waste
- Flocculation of the pollutant

Applications

- Dissolved and emulsified oils/grease
- Surfactants
- Cyanide
- Aromatic compounds: Benzene and Xylene

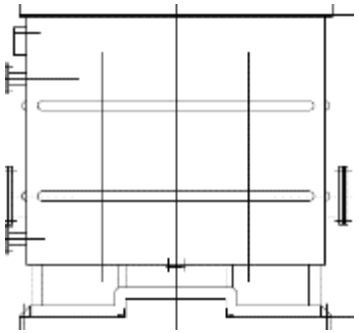
Advanced Oxidation Technology

SHR (6 m^3/hr)

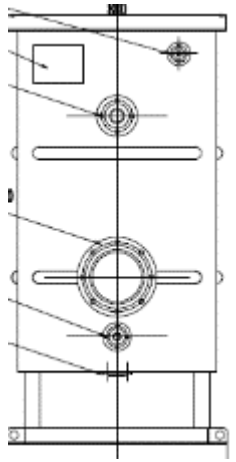
- Atmospheric Operating Condition
- 10 mins for each stage of reaction
- Inputs:
  - ❑ Compressed Air
  - ❑ Waste-Water
- No additional chemicals required
- Long operational life / minimal maintenance
- The media material is not consumed in reaction but may need to be clean/replace

Advanced Oxidation Technology

Dynamic Hydro Reactor - DHR



The system consists of a low voltage electrode array and specially designed proprietary packing which together creates a three-dimensional electrolytic effect.



When the reactor is injected with air the resultant electrical energy (excitation energy) from the array induces the formation of hydroxyl (·OH) radicals.

A chain reaction that causes the catalytic reduction/oxidation of the organic pollutants

Advanced Oxidation Technology

DHR (3 x 2m³/hr)

- Atmospheric Operating Condition
- 20 mins for each stage of reaction
- Inlets:
  - ❑ Compressed Air
  - ❑ Waste-Water
  - ❑ 48 VDC electrical input
- No additional chemicals required
- Long operational life / minimal maintenance
- The media material is not consumed in reaction but may need to be clean/replace

Project Reference (Jubail, Saudi Arabia)

Modify/Enhance existing system as **Pre-Treatment**

18,000 m^3/day

Polishing Agent before discharge of effluent

Novexx

Thank You For Listening

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11 MAY 2021 TUESDAY

3:00pm ~ 4:30pm (SGT)
9:00am ~ 10:30am (CET)

Coordinated and co-organized in Denmark by the following partners:

DANISH EXPORT ASSOCIATION WATER · EMBASSY OF DENMARK Singapore · ACCESS CITIES · CITY OF COPENHAGEN · QUERCUS GROUP · eit Climate-KIC · CITY OF AARHUS · State of Green Connect. Inspire. Share. Think Denmark · DI Confederation of Danish Industry

WATER RESOURCE RECOVERY

An Online dialogue between **Denmark** and **Singapore**
on key innovations and opportunities ahead in the water sector

SWA Singapore Water Association · DANISH EXPORT ASSOCIATION WATER

Upcoming

- **17 May 2021, 3pm to 4pm**
  [Webinar] Deepen Your Workforce Digital Capabilities With SME Digital Reboot
- **19 May 2021, 3pm to 4pm**
  [SWA Industrial Water Series]
  Sharing of water opportunities in industrial projects in Philippines and Vietnam
- **21 May 2021, 3pm to 4pm**
  [SgWX Water Utilities Series]
  Water Management & Strategies of the Metropolitan Waterworks Authority (MWA)
- **27 May 2021, 3pm to 4:30pm**
  [Webinar] Storming Innovations with SIMTech

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For further queries on the webinar, please contact :

THANK YOU

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